(Bulletins 276 to 284 constitute the Report for 1919. In binding, pages i-xvi at the end of this bulletin should be detached and placed before Bulletin 276 which begins with page 1).

Maine Agricultural Experiment Station

ORONO

BULLETIN 284 **DECEMBER, 1919**

ABSTRACTS OF PAPERS NOT INCLUDED IN BULLETINS, FINANCES, METOROLOGY, INDEX.

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MAINE

AGRICULTURAL EXPERIMENT STATION

ORONO, MAINE

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BULLETIN 284

ABSTRACTS OF PAPERS PUBLISHED BY THE STATION IN 1919 BUT NOT INCLUDED IN THE BULLETINS.

A complete list of all the publications issued by and from the Station in 1919 is given on pages x to xii of the introduction to this Report. The following pages contain abstracts of the papers issued during the year that are not included in the Bulletins or Official Inspections for the year.

VARIATION OF AYRSHIRE COWS IN THE QUANTITY AND FAT CONTENT OF THEIR MILK.*

This paper presents the results of a biometrical analysis of variation in the quantity per unit of time, and the quality, as indicated by fat percentage, of the milk of Ayrshire cows. Its purpose is to establish normal constants for interindividual variation in these characters, to serve as a base of reference in future genetic studies on milk production.

The chief results of this first part of the investigation may be summarized as follows:

The mean weekly yield and fat percentage of the milk change in a considerable degree and definite manner with increasing age of the cow.

The weighted mean standard deviation and coefficient of variability for mean weekly yield of cows of any given age are 2.806 gallons and 17.081 per cent respectively. Reasons are given tending to show that these may be taken as very close approximations to true normal values. For cows of all ages lumped together the corresponding values are 3.329 gallons and 20.816 per cent.

For fat percentage the weighted mean values for cows of any given age are as follows: Mean=3.738, standard deviation =0.330, and coefficient of variation=8.827.

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*This is an abstract from a paper by Raymond Pearl and John Rice Miner having the same title and published in the Jour. Agr. Research, Vol. XVII, No. 6, pp. 285-323.

A table is presented showing the relative variability of milk production as compared with other physiological characters. The udder as a secreting organ is compared with the oviduct of the hen; and it is shown that the oviduct considered as a mechanism operates with somewhat less variability than does the udder, having regard to the absolute weight of the product in the two cases.

Evidence is presented which indicates that about one-half of the observed variation in milk production results from the varying genotypic individuality of the animals with respect to this character and that the other half results from varying environmental influences.

Milk production curves, analytically considered, tend definitely toward positive skewness. This is true in respect to yield and to quality. The weighted mean value of the skewness for mean weekly yield is found to be +0.1047, and that for fat percentage +0.1338.

Evidence is presented which indicates that selection can have had little if anything to do with determining the direction or the amount of skewness shown by milk production curves.

The curves for milk yield tend on the whole to fall more frequently in unlimited range types, while those for fat percentage tend more to limited range types. The estimation of range ends given by the theoretical curves are, on the whole, good.

In general the tendency of milk yield curves is toward the leptokurtic condition—that is, they are more peaked than the corresponding normal curves would be. Fat percentage curves do not show any definite tendency with respect to kurkosis.

Certain of the milk yield curves were dissected into two normal curves by Pearson's method. The resulting graduation was not so good as that given by the appropriate unimodal skew frequency curve. There is no evidence that variation curves for milk production curves are biomodal.

The change in mean weekly yield of milk with advancing age is found to be represented by a logarithmic curve, and to be in accordance with a law which may be stated in this way: The absolute amount of milk produced per unit of time increases with the age of the cow until the maximum is reached, but the rate of increase diminishes with advancing age until

the absolute maximum of production is reached. After the time of maximum productivity, the absolute production per unit of time decreases with advancing age at a continually increasing rate.

The mean fat percentage of the milk was found to decline with advancing age until the tenth year of the cow's life is reached. From that point on, the fat percentage remains about constant through the remainder of the milking life of the cow.

STUDIES IN MILK SECRETION. V. ON THE VARIATIONS AND CORRELATIONS OF MILK SECRETION WITH AGE IN JERSEY CATTLE.*

The purpose of this paper is to present quantitative data, along with the biometrical analysis of the same, on the normal variations and correlations of milk production during the cow's life. The necessity of such data and analyses is, now, well recognized in physiological and genetic investigations on a quantitative subject. The economic value of milk makes this investigation have a significant relation to improvement in yield and in the selection of cows to remain within the herd. The materials used for this study are peculiarly suited to the ends in view. They are a strictly homogeneous group of milk records of normal pure bred Jersey cows maintained under the conditions of a large farm, managed by a well trained man thoroughly versed in his business. While the conclusions derived from this study are stated in general form, it is not presumed that the conclusions are of more generality than the data on which they are based. It is altogether probable however that the conclusions drawn do apply to most of the other dairy breeds of cattle.

The conclusions of most moment may be summarily stated as in the following paragraphs. Unless otherwise stated, the conclusions apply to the pure bred Jersey herd the data for which are given in this paper.

The frequency polygons for milk production are only slightly unsymmetrical. The range of variation is large, one cow producing less than 1500 pounds in her eight months' lac-

*This is an abstract from a paper by John W. Gowen having the same title and published in the Genetics, Vol. 5, No. 2.

tation period, another cow producing more than 10,000 pounds for her eight months' lactation period. The height of the modal ordinal for the frequency polygons is greatest in the earlier and later years of the cows' lives. Only one mode is evident in any of the histograms. From this it appears likely that these curves are unimodal curves. Too much stress should not be laid on this however since certain of the distribuitons appear quite flat topped.

The analytical constants show that the eight months' milk production curves are of the Pearson types I, II and IV groups. The skewness of these curves is all in the positive direction and rather small in amount. This small size of the skewness is of considerable interest to those investigators who deal with advanced registry data since it would indicate that these data can with but small error be fitted by normal curves to determine certain of their needed constants.

The correlation coefficient between age at the commencement of test and milk production in comparison with the correlation ratio for the same variables shows that the regression of milk production on age is far from linear. This regression curve when analyzed turns out to be a logarithmic function. Attention is called to the fact that this same kind of logarithmic function also describes the relation of growth to age. This paralleling of the two functions may indicate that a causal relation exists between them such that increased milk production chiefly depends on increase in size of the mammary gland caused by growth.

The standard deviations of milk production progressing from the heifer to the aged cow are described by a cubic parabola. This regular change of the standard deviation of milk production groups shows that the curve formed by them falls into the heteroscedastic, nomic class as defined by Pearson.

Correlation tables for milk production of the different age groups are presented.

The means derived from these tables of a given age remain within the limits of random sampling irrespective of the age at which the same cows were subsequently tested.

The standard deviations for the various age groups also remain at the same value within the limits of sampling irrespective of the age at which a subsequent test may be made.

As would be expected from their derivation and as actually checks out to be the coefficients of variation do not change within the age group for the cows which are retained in the herd for longer or shorter periods. These facts show that the cows which were kept in the herd as two year olds were all equally likely to be kept in the herd until they became aged cows as far as the milk production of these two year olds was concerned. Generalizing this statement cows which were kept in the herd at any given age were all equally likely to be kept in the herd at any other age as far as the milk record of any of those cows at the given age was concerned. This point removes any possible objection to the accuracy of the correlations for the milk productions at the various ages at least so far as concerns the cows remaining in the herd on the basis of their milk production being high.

The correlation coefficients for the milk production of one lactation with that of another lactation at another age range from $+0.2144 \pm .0919$ to $+0.7306 \pm .0284$. The signs of these correlation coefficients are all plus. The numerical values are large enough to be significant. Each set of correlation coefficients for the milk production at a given age with the milk productions at other ages in the cow's life do not deviate significantly from a line taking a nearly constant value for each age. The mean value for these correlation coefficients of milk production of one lactation at any age with the milk production of another lactation at another age is $+0.5352$.

This mean value of the coefficient of correlation seems to be generally applicable to milk production for on somewhat similar data Gavin finds results which are comparable to these.

These correlation coefficients are high for this kind of data as may be seen from the fact that correlation coefficients of similar nature for egg production range lower and have a lower mean $+0.4458$ than do these correlation coefficients for milk production.

The magnitude of these correlation coefficients in comparison to those on egg production put in terms of the physiology of the two sets of glands, mammary and ovary, that the mammary gland works with more mechanical precision than does the ovary.

The linearity of all the regressions is established by the calculation of the correlation ratios and their comparison with the corresponding correlation coefficient.

From the means, standard deviations and correlation coefficients are formed the straight line equations for the prediction of the amount of milk production of any given lactation at any age from these known variables at another age. These equations are tabled. Examination of these equations seems to show that most stress is laid on the milk production at two years old by the coefficients, indicating that the milk production at this age represents most accurately of all others the future possibilities of the cow. Similar analysis reveals the fact that correction of the milk records to the age about the time of maximum productivity of the cow gives the nearest approach to the correct milk production for that cow.

The correlation coefficients of milk production at a given age with the total milk production of two lactations are presented. These correlations prove to be very high ranging from $+0.7324 \pm .0286$ to $+0.943 \pm .0116$. Such high values make it appear that the milk production of one lactation is the determining factor for total milk production of two lactations when the given lactation is one of the components.

This conclusion is confirmed by a study of a smaller series of data where the first five lactation records are known, the first commencing at two years old and the other four commencing approximately at one year apart. These correlation coefficients for milk production of a lactation at a given age with the total milk production over the five lactations range from $+0.7416 \pm .0323$ to $+0.8613 \pm .0186$. Each regression is linear as is shown by a comparison of the correlation coefficients and correlation ratios.

A means of measuring the effect of environmental changes on the coefficient of correlation of the milk production of a lactation at a given age with the milk production of a lactation at another age is given. This measure depends on the difference in the correlation coefficients of the milk production of a given age correlated with the milk productions of several successive lactations and the correlation of the milk production of the given lactation and the total milk production of the other lactations. In the first case the environmental changes of the

different lactations as they effect milk production make themselves felt in the correlation coefficients; in the second case the use of the total milk production gives a mean of these environmental effects. The outcome of this study shows the environmental changes reduce the correlation one-seventh to one-eighth of what it would be under the conditions of an average environment. This result makes it clear that for these Jerseys heredity plays a greater part in their milk production from lactation to lactation than environment.

The correlation coefficients for the milk production of one lactation with that over several lactations, furnishing as it does the basis for the regression formula by which milk production over long periods may be predicted from shorter ones, is of the greatest practical importance in culling the herd of the mediocre animals. The use of these coefficients is illustrated by table.

The relative contribution of the different lactation to the total milk production over a longer period shows that the factors which govern milk production have their regulatory power maintained in the same relative strength throughout the life of the cow to the exclusion of any group of factors acting within this life for any short period.

STUDIES IN MILK SECRETION. VI. ON THE VARIATIONS AND CORRELATIONS OF BUTTER-FAT PERCENTAGE WITH AGE IN JERSEY CATTLE.*

This paper has as its object the presentation of quantitative data along with the biometrical analysis of the same, on the normal variations and correlations of the butter-fat percentage contained in Jersey milk during the different lactations of the cow's life. In this sense this paper is the copartner to the previous paper in this series dealing with the variations of milk yield for these same Jersey cows. The data used for this study are especially suited to the objects of this investigation. They are from a strictly homogeneous group of records for the butter-fat percentage of normal, healthy, pure bred Jersey cows main-

*This is an abstract from a paper by John W. Gowen having the same title and published in Genetics, Vol. 5, No. 3.

tained under the conditions of a large farm, managed by a well trained man thoroughly versed in his business. While stated in general form the conclusions are not presumed to be more general than the data on which they are based. Certain comparisons with other data contained in the body of the paper make it seem altogether probable that to a large degree the conclusions are of general application to most of the other dairy breeds of cattle. The well recognized need for such data and analysis in physiological and genetic research and the significant relation such data have to the improvement in yield and in the selection of cows to remain within the herd have made it seem desirable to present as complete numerical data as possible.

The following paragraphs briefly state the conclusions which are considered of most importance. Unless stated to the contrary, these conclusions apply to the pure bred Jersey herd the data for which are given in this paper.

This investigation deals with 1713 records for the butter-fat percentage of the first eight months lactation, each cow milking at least nine months. The frequency polygons for butter-fat percentage are nearly symmetrical. One only, at the ages nine to ten years, diverges noticeably from this form. The range of variation extends from 3.65 to 6.95 percentage of butter-fat. The height of the modal ordinate and the shape of the polygons do not change markly with age as was the case for milk production. Only one mode is evident in any of the histograms.

Comparatively studied the butter-fat in the milk secreted by twenty-eight breeds of cows shows that the means of these breeds form a distribution distinctly bimodal in characters. The mode of the first curve coming at about 3.7 and of the second at about 5.0 per cent of butter-fat.

Study of the standard deviation of typical members of the above groups shows a greater scatter in the butter-fat percentages in the group where the butter-fat concentration is high than in the group where the butter-fat concentration is low.

The analytical constants show that the butter-fat percentage histograms of the eight months milk production are Pearson's type I, III, IV and V, and normal curves. The skewness of these curves, where they are skew, is plus four times and minus twice. The skewness for each curve is small in amount. This

relatively small size of the skewness has some interest to those investigators who deal with advanced registry records since within a small error normal curves may be considered to describe the general population from which the truncated portion is drawn in advanced registry selection.

The correlation coefficient of butter-fat percentage with age is 0.1126±.0161. The correlation ratio calculated from the same data is 0.1478±.0159. The excellent agreement between these two constants show that the regression of butter-fat percentage on age is to all intents and purposes linear. The highest mean butter-fat occurs in the first lactation of a cow's life. From this high point there is a slight decline in the butter-fat percentage as age advances.

Comparison of these correlations with those for the other breeds, Guernsey, Ayrshire and Holstein-Friesian leads to the following law expressing the relation between age and butter-fat percentage; each increment of time added to a cow's life causes a slight decline in the relative amount of butter-fat which that cow can secrete into her milk.

The standard deviations of butter-fat percentage decreases very slightly with advancing years. The function describing this decrease is a linear one.

Correlation tables for butter-fat percentage for lactations during certain age groups are present.

The mean butter-fat percentages derived from these tables remain, within the limits of random sampling, the same for any given age at test irrespective of the age at which the same cows were subsequently tested.

The standard deviations of the butter-fat percentage for the various age groups remain at the same value within the limits of sampling irrespective of the age at which a subsequent test was made.

The coefficients of variation for the butter-fat percentage of the various ages also remain approximately constant irrespective of the age at which a subsequent test was made on the same cows.

These facts show that cows kept in the herd at any given time were all equally likely to be kept in the herd at any other time so far as their eight months butter-fat percentage was concerned. This point removes any possible criticism of the con-

clusions drawn from these studies on the ground that the data was subject to selection.

The correlation coefficients for the butter-fat percentage of one lactation with the butter-fat percentage of another lactation range from $0.2470 \pm .0640$ to $+0.6781 \pm .0310$. The sign of these correlation coefficients are all plus. The grafts of these correlations are approximately linear. Very little or no difference occurs in the values of the correlations of the butter-fat percentage at a given age with the butter-fat percentage for another age.

Comparison of these correlation coefficients with those for milk production shows that the average coefficient of correlation for the butter-fat percentage of one lactation with that of another lactation is $+0.5215$ and the average correlation coefficient for milk production of one lactation with another lactation is $+0.5352$. The correlations for milk production are higher, although not significantly so, than those for butter-fat percentage. Such being the case it follows that the relative accuracy in the use of one lactation record to predict the expected record of another lactation is approximately the same for the butter-fat percentage and for milk yield.

These correlation coefficients are high for data of economic importance. The mean coefficient of correlation for monthly egg production with the yearly egg production is $+0.446$. The range is also lower than these correlations for butter-fat percentage. In terms of physiology this difference in the correlation coefficients for ovulation and butter-fat percentage means that the mechanism controlling the mammary gland has greater precision in its action than has the mechanism controlling the action of the ovary.

The correlation ratios were calculated. Comparison of these correlation ratios with the correlation coefficient show all of the regressions to be linear regressions.

The means, standard deviations and correlation coefficients give the necessary constants to form the straight line equations for the prediction of the butter-fat percentage of any given lactation at any age from these known variables at another age. The equations are given. Examination of these equations shows that the age at which the butter-fat percentage determined for the milk most nearly represents the cow's potentialities is five

years. The age to which to predict the butter-fat percentage of the other years to arrive at the most nearly accurate result is two years. The correlation coefficients for butter-fat percentage of a given lactation with the butter-fat percentage of two lactations of which the given lactation is one component range from $+0.7048 \pm .0343$ to $+0.9181 \pm .0090$.

The correlation coefficients of the butter-fat percentage of one lactation with the butter-fat percentage of the first five lactations range from $+0.784$ to $+0.862$. Each regression is shown to be linear by a comparison of the correlation coefficients and correlation ratios. The regression equations for the prediction of the five year butter-fat percentage from the percentage of any given year are given.

The difference of the correlation coefficients for one lactation's butter-fat percentage with that of another lactation and for one lactation's butter-fat percentage with the butter-fat percentage over four lactations has been determined. The difference of these correlation coefficients gives a means of measuring the effect of environmental changes on the butter-fat percentage of one lactation since in the first case the environmental changes of the different lactations as they effect milk production make themselves felt in the correlation coefficients and in the second case the use of the butter-fat percentage for the four lactations give a mean of these environmental effects. The upshot of this comparison showed that environmental changes lower the correlation coefficients from one-seventh to one-eighth of what it would be under the conditions of an average environment. The environmental effect on butter-fat percentage is consequently about the same as the environmental effect on milk production. Since the internal governing action of the cow for milk production has nearly six times the effect on controlling milk production than has the environmental changes, it follows that this internal mechanism (probably hereditary) plays greater part in determining what these Jerseys' butter-fat percentage will be than does the environment.

The equations to predict the butter-fat percentage of the first five lactations from the butter-fat percentage of a single lactation are of great importance in culling mediocre cows from the herd. The use of these equations is illustrated.

The relative contribution of the butter-fat percentage of the different lactations to butter-fat percentage over the first five lactations is the same up to the fifth lactation. In the fifth lactation the correlation coefficients would seem to indicate a slightly less relative contribution of the higher test cows to the five lactation butter-fat percentage than is the relative contribution of the lower test cows. In general, since the significance of this correlation is only slight, the conclusion can be safely drawn, that the factors which govern butter-fat percentage have their regulatory power maintained in the same relative strength throughout the life of the cow to the exclusion of any group of factors acting within this life for short periods.

ON VARIATION IN TARTARY BUCKWHEAT, FAGOPYRUM TATARICUM (L.) GAERTN.*

The purpose of the present publication is to record the results of a study on a highly variable, ever-sporting race which the writer has discovered in Fagopyrum tataricum. The race with which this paper deals originated from commercial fruits of Fagopyrum tataricum, Tartary buckwheat, also known as India wheat, which had been grown in Maine.

The more important observations recorded in this paper may be summarized as follows.

An ever-sporting race of *Fagopyrum tataricum* has been isolated and its characters studied for 5 generations under varying conditions of environment.

The variations here considered occur in the gynoecium, the perigone, and the vegetative organs of this race.

The variations in the gynoecium are characterized by the production of supernumerary carpels. The number of carpels per pistil was found to vary from 3 up as high as 25. Under ordinary conditions of growth the number of flowers with normal gynoecia is greater than or equal to the number of flowers with abnormal gynoecia. Under conditions favoring the development of abnormal flowers the variation is bilateral, and

*This is an abstract from a paper by Jacob Zinn having the same title and published in "Genetics," Vol. 4, No. 6.

can be represented by a curve the apex of which is formed by the abnormal four-carpelled flowers.

The frequency of flowers with abnormal gynoecium decreases as the number of aberrant carpels per pistil increases.

Associated with the abnormal gynoecia are abnormal perigones with a varying number of segments ranging from the normal number 5 as high as 18. The favorable conditions capable of transforming the unilateral variation of the gynoecia into a bilateral one, failed to affect the perigone in the same manner. The variation in the number of perigone leaves remained unilateral with the frequency of the normal, five-parted perigone forming the apex of the skew curve.

The frequency of the normal, five-parted perigone decreases as the number of carpels per pistil increases.

Floral prolifications in the form of various types of synanthous flowers, often giving rise to syncarpous fruits, were found to be produced generation after generation in fairly constant proportions under given conditions of environment.

The teratological development of the vegetative organs in the form of more or less developed fasciations was reproduced, under favorable conditions of environment, in 50 per cent of the offspring.

All the descendants of the ever-sporting race reproduce the ever-sporting type of the mother plant regardless of whether they originated from normal or abnormal fruits of the parent.

The ratio between the normal and abnormal flowers was found to be a function of the environment. Under a given set of environmental conditions this ratio as well as the relationship between the different forms of the abnormal flowers *inter se* is constant to a very marked degree.

Selection carried on for 5 years had no visible effect upon the type and range of teratological development of this race. The ever-sporting strain after isolation at once displayed the highest degree of abnormality reached in the subsequent generations under similar conditions of environment.

Under conditions controlling the intensity of abnormal development, optimum nutrition or starvation, while affecting the habit of the plants, appeared to have no effect upon the degree of manifestation of abnormalities. The evidence from the study of this race under different conditions of environment points

to high humidity and temperature as the factors favoring the expression of abnormality. Under unfavorable conditions of humidity and temperature, the influence of starvation and lack of water upon the degree of abnormal development was noted.

The results of a study of the frequency distribution of the different types of flowers upon the plant point to the existence of a definite region on the plant in which the tendency to vary and proliferate is most pronounced. Considering the plant as a whole, this region is confined to the basal, differentiated parts of the plant. The first three branches on the main stem from below, especially the second one, mark the seat of greatest abnormal development, while the 4th, 5th, and 6th branches show a low degree of variability as well as the lowest absolute number of flowers. In the basal region of the terminal raceme the output of flowers and the range of abnormality again increases. Similar but more marked differences prevail in the individual branches of the second and third order. Here, it is again the buds in the axils of the second leaf and in the basal region of the terminal raceme that show the greatest relative number of abnormal flowers as well as the greatest range of variability as measured by the frequency occurrence of the most aberrant variants.

Relative to the frequency occurrence of the different types of flowers at different periods of the flowering season, under the prevailing conditions, the first and second week of the flowering season mark the lowest relative production of abnormal flowers, after which a marked increase in the output of abnormalities follows when the secondary and tertiary branches begin to develop their flowers. Towards the end of the flowering season the upper regions of the plants produced only very few flowers while the lower differentiated parts of the plants sustained their flower production to the end of the flowering season.

CONFORMATION AND ITS RELATION TO THE MILK PRODUCING CAPACITY IN JERSEY CATTLE.*

This paper presents a biometrical analysis of the relation of conformation to the milk producing capacity of the Jersey

*This is an abstract from a paper by John W. Gowen having the same title and published in Jour. Dairy Science, Vol. 3, No. 1.

cow. Exceptional data have been made available to this Station for the solution of this problem by the courtesy of Mr. R. M. Gow. These data give the exact scores of 1674 registry of merit Jersey cows as determined by about 140 judges.

The mean conformation as measured by score is given for the cow as a whole and for the parts into which it is divided. Within this group of Jersey cows the average score was 89.848 ±.073. The average Jersey cow was therefore about 10 points below the ideal Jersey cow. When this measure of the conformation as a whole is analyzed in terms of its parts, it was found that the fore udder differed most from the ideal type.

When considered in abstract terms it was found that the most seriously defective parts of the body in the minds of the judges had to deal with the mammary system, its size and blood supply. Of those parts which dealt with the body proper the least ideal was the barrel.

The variation of the different body parts is compared by means of the standard deviation and the coefficient of variation. The most variable part of the body included the eyes, horns and muzzle, the least variable the size of the body.

The variability is futher compared with characters of similar nature to those of conformation save that the variability was determined on data measured or weighed accurately in English or metric units. Bone material was in general found to vary less than the scores assigned to parts of the body depending chiefly on variations in bone length. The amount of this difference was slight, however. The variation of the udder parts was found to be at the lower end of the range of variation of other soft parts of the body.

Correlation coefficients for milk yield with the conformation as a whole and for the various parts were determined. The correlation coefficients ranged from —0.0697±.0165 to +0.1941 ±.0160. Out of the nineteen correlations only one was minus in value; seventeen were more than three times their probable error. The total score had the highest correlation with milk yield. The parts of the conformation having a distinctly significant relation to milk production of the cow were the milk veins, size and condition of udder, the size and shape of rear udder, the shape and size of barrel and the general appearance of the cow.

The relative merits of conformation as a guide to the milk producing capacity of a cow and a short time milk record are considered. The results show that a seven day test has a correlation coefficient with the year milk yield of the cow of approximately 2½ times that of the conformation or any part of the conformation. The short test consequently is superior to the conformation as a guide to milk production.

A BIOMETRICAL STUDY OF CROSSING OVER. ON THE MECHANISM OF CROSSING OVER IN THE THIRD CHROMOSOME OF *DROSOPHILA MELANOGASTER*.*

This paper presents an analysis of the normal fluctuating variations in crossing over from the viewpoint of the theories advanced to account for crossing over. The means, standard deviations and coefficients of variation show crossing over to be one of the most highly variable phenomena known. Consequently the mechanism behind crossing over works with less precision than the mechanism behind most other physiological phenomena. Resolution of the single crossing over ratios into their component elements shows that there is a significant correlation between crossing over of the different regions into which the chromosome is divided by the factors used. The correlation between the single and double crossing over ratios shows that a crossing over in one region is more likely to be accompanied by another simultaneous crossing over in a region 25 to 35 units away than it is to be accompanied by a simultaneous crossing over in any other region. Thus the left hand region (1) correlated with double crossing overs including one, gave correlations, proceeding from left to right, $+0.3054\pm.0395$, $+0.5170\pm.0319$ and $+0.2997\pm.0396$. This rise and fall, together with a definite mode, is held to mean that there is a model interval between two successive crossing overs. Thus the two finely spun out chromosomes, when they come together prior to crossing over, apparently twist about each other loosely and generally have the points of contact where breaking may take place about 25 to 30 units apart.

*This is an abstract from a paper by John W. Gowen having the same title and published in Genetics, Vol. 4, No. 3, pp. 205-250.

REPORT ON THE WHITE PINE WEEVIL.*

This paper gives a description of the White Pine Weevil, an account of its habits, the damage it causes and a discussion of control methods.

The writer states: "Scientifically there seems to be no reason why the pine weevil should not be controlled throughout the state—or indeed throughout its range—and their numbers so reduced that a pine or spruce infested by them should become a rarity. There is no real reason why the "stag-horn" pine and the "bushy" pines along the roadsides and in the woodlots and plantations should not give place to symmetrical trees growing in the way nature intended them to grow; no reason why the present unsightly, stunted trees should not be replaced by objects of real beauty and from being of no value, become the producers of the most valuable timber it is possible to grow in the state. The writer thoroughly believes that the control of the pine weevil is a practical proposition. All that is necessary is a concerted, cooperative effort by all land owners, directed and aided by a corps of experts employed by the State. The cost for a few years would be considerable, but it would not be excessive when the increased value of the woodlands is taken into consideration. The State would be a more attractive place to live in, and the coming generations would not only receive a heritage of greater beauty, but could also reap a crop of immensely greater value."

Following this are suggested systems of planting white pine and Norway spruce to obviate weevil injury.

REPORT ON THE SPRUCE BUDWORM.*

"The spruce budworm (*Tortrix fumiferana* Clemens) is with small doubt the most destructive enemy of the spruce, fir and hemlock in Maine."

*This is an abstract of a paper by M. W. Blackman, having the same title and published by the Maine Forestry Department in cooperation with the Forestry Department, University of Maine and the Maine Agricultural Experiment Station.

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"The present outbreak seems to be a much more serious and destructive one than that of thirty years ago, for its extent comprises not only the coast regions but practically every wooded area of the state."

"Usually one's attention is first attracted to this insect in the spring or early summer by the wilted or blighted appearance of the new growth at the ends of the branches and twigs of spruce and balsam. This has often been described as resembling the effect produced by the passage of a light fire through the woods."

"The feeding of the larvae upon the developing tips of spruce or balsam usually completely kills them and as no more can be reproduced until the following season the tree is greatly weakened. However, to completely kill the tree, it is necessary either that all or nearly all of the old leaves be also eaten, or that the destruction of the buds shall continue several seasons, or that the greatly weakened tree shall be attacked by other insects, such as borers which complete the destruction. Thus, but few trees are killed the first year of attack unless complete defoliation both of the new and old needles has resulted, but for the succeeding few years the results are cumulative, as each succeeding crop of new leaves is nearly entirely destroyed, while in the meantime the old ones are being lost in the natural way. When, however, bark beetles and bark weevils attack trees already weakened by nearly complete defoliation, as has been recently reported by Swaine in Canada, they find but little resistance to overcome and the trees readily succumb."

"A number of trees, some recently dead, others apparently dying, and others seriously and nearly completely defoliated, were felled in order to examine them for boring insects, either bark beetles, weevils or others, which might follow the attack of the budworm and contribute to the death of the trees weakened by defoliation."

In this connection the work of the following insects was observed. Sawyer, *Monohammus scutellatus;* balsam bark beetle; *Pityokteines sparsus* Lec.; *(Ips balsameus* Lec.); *Pissodes dubius; Cryphalus balsameus* Hopk.; spruce bark beetle *(Polygraphus rufipennis* Kirby); *Dryocoetes affaber* Mannh; *(D. piceae* Hopk.); *Eccoptogaster piceae* S. W.; *Pissodes nigrae.*

"While it is undoubtedly possible to control the bud moth by spraying the affected trees in the spring with arsenate of lead (5 lbs. to 100 gals. water) this is practical only for ornamental and park trees."

"The woodsland owner can, however, lessen the danger of the much increased loss which will occur if the trees which are weakened by the budworm are attacked by hordes of beetles capable of breeding in them and completing their destruction. This he can do by using proper methods in his logging operations."

"Trees killed by the budworm are by no means valueless, as they will remain sound for several years and can be utilized for pulp-wood, provided they are not riddled by wood boring insects."

STUDIES ON THE VIABILITY OF THE POTATO BLACKLEG ORGANISM.*

Field studies and other general observations indicate that in Maine the bacteria which cause potato blackleg do not remain alive over winter in the soil where the disease has occurred. This paper has to do with certain experiments the primary object of which was to obtain more accurate data on this point, under control conditions; also to determine whether this apparent inability of the bacteria to remain alive in the soil was due to the low temperatures of the winter months or simply to the fact that they were unable to retain their vitality in the soil when separated from the host plant or after they had produced complete decay of the tissues of the latter.

Potato tubers inoculated with pure cultures of the blackleg organism, *Bacillus atrosepticus* Van Hall, after they began to decay were kept at 0° C., or a fraction of a degree above, for from one to 11 days and were then planted in the greenhouse. All of these tubers decayed and only a small proportion of them were able to produce sprouts that reached the surface of the soil. These sprouts died down almost immediately with blackleg. The pots of soil containing these diseased tubers were

*This is an abstract of a paper by Glen B. Ramsey, having the same title and published in Phytopathology, Vol. IX, pp. 285-288, 1919.

replanted with healthy tubers just a month after the second planting. This time healthy plants were produced which matured without any signs of blackleg whatever. Exposure to temperatures close to the freezing point for from 1 to 11 days, retarded the activity of the blackleg organisms as the period of exposure increased, but did not prevent their causing a complete decay of the tubers after the latter were planted in pots in the greenhouse, and, under the favorable conditions of moisture and temperature in the pots of soil in the greenhouse, they failed to retain their vitality for as long as 30 days.

Duplicate samples of 3 different soil types were taken in the fall. These were placed in small fruit jars, a virulent culture of *B. atrosepticus* was poured over each, and the covers of the jars screwed on tightly. One set of jars representing each soil type was buried 5 inches deep in soil outside while the other set were stored in the basement of an unheated building. Attempts to isolate the blackleg bacteria from these different samples of the soil in the spring were unsuccessful. The experiments mentioned above, taken together, indicate that the blackleg organism remains alive in the soil but a very short time even under favorable conditions. Also infected tubers left in the ground at digging time decay to such an extent that they do not germinate or if they do germinate the sprouts are immediately killed by the parasite. This explains why volunteer plants are always free from the disease, even though blackleg was prevalent on the same field the season before.

In order to test the possibility of blackleg spreading from plant to plant in the field, or from diseased tubers remaining in the soil from the season before, and which might not entirely decay during the previous fall and winter, quite an extensive experiment was carried out during two successive seasons. Pots of different soil types were sunk in the ground out of doors, with their tops flush with the surrounding surface. Healthy potato plants growing in these pots were watered at intervals, beginning shortly after they came up, with varying dilutions of *B. atrosepticus*. The results convinced the writer that, unless the seed piece is infected at planting time there is little chance that uninjured plants will contract the disease even though the causal organism is washed about the stem and root system.

INVESTIGATIONS ON THE MOSAIC DISEASE OF THE IRISH POTATO.*

This is a preliminary paper describing the results of research conducted upon potato mosaic in four laboratories during the years 1916-1919. After discussing the geographical distribution, the previous work concerning the effects upon yield, and the characteristic symptoms, evidence is presented upon various phases, summarized as follows.

Potato mosaic decreases the yield decidedly. It is transmitted by the tubers of affected plants and is thus maintained in a stock from year to year. It also spreads in the field so that healthy plants may have progeny partly or wholly diseased. While the disease is characterized by certain physiological abnormalities, its cause is an infectious substance that can be transferred from plant to plant by means of grafting, plant juice, and plant lice. Transmission by plant lice was demonstrated in a number of experiments of various kinds. Two species common upon potato plants were used. Transmission in the field has been greatly reduced, but not entirely eliminated, by the removal of diseased plants from seed plots, while hill selection has been much less successful as a method of control.

It appears that in order to reduce the detrimental effects of the disease it is necessary both to avoid diseased stock and to prevent field infection of healthy stock by plant lice.

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*This is an abstract of a paper by Donald Folsom and certain cooperating members of the Bureau of Plant Industry, having the same title and published in the Jour. Agr. Research, Vol. XVII, No. 6, pp. 247-274.

METEOROLOGICAL OBSERVATIONS.

For many years the meteorological apparatus was located in the Experiment Station building and the observations were made by members of the Station Staff. June 1, 1911, the meteorological apparatus was removed to Wingate Hall and the observations are in charge of Mr. James S. Stevens, professor of physics in the University of Maine.

In September, 1914 the meteorological apparatus was again moved to Aubert Hall, the present headquarters of the physics department.

The instruments used were at Lat. 44° 54′ 2″ N. Lon. 64° 40′ 5″ W. Elevation 135 feet.

The instruments used are the same as those used in preceding years, and include: Maximum and minimum thermometers; rain gauge; self-recording anemometer; vane; and barometers. The observations at Orono now form an almost unbroken record of fifty-one years.

METEOROLOGICAL SUMMARY FOR 1919.

Observations Made at the University of Maine.

1919	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total
Highest temperature	40	47	64	65	78	98	95	82	75	72	59	44		
Lowest temperature	—14	— 3	0	14	32	35	49	41	33	18	15	—17		
Mean temperature	20.05	24.5	33.6	41.2	33.8	65.2	69.0	63.1	55.9	45.6	35.4	18.5	42.15	
Mean temperature in 51 years	16.13	14.78	30.20	40.04	51.27	60.85	66.0	66.03	59.63	50.63	38.02	24.07	42.73	
Total precipitation in inches	3.65	1.1	3.02	2.29	4.08	1.44	4.07	.92	3.07	2.31	2.81	1.80		30.56
Mean precipitation in 51 years	2.56	3.42	3.97	2.91	3.54	3.43	3.50	2.30	3.41	3.83	3.42	3.47		39.76
Number of days with precipitation of .01 or more	2	3	10	8	7	8	12	9	10	8	10	8		95
Snowfall in inches	18	11	3.2	3								3.8		39
Mean snowfall in 51 years	21.7	21.2	14.91	5.88	.225					.725	6.88	16.48		
Number of clear days	14	20	19	16	19	23	24	19	16	15	12	20		217
Number of fair days	10	5	7	10	6	5	6	9	7	11	8	6		90
Number of cloudy days	7	3	5	4	6	2	1	3	7	5	10	5		58
Total movement of wind in miles	2998	3467	2961	4600	2462	3506	3028	2563	3441	3243	4370	3330		39669

REPORT OF THE TREASURER

The Station is a department of the University and its accounts are kept in the office of the Treasurer of the University. The books, voucher files, etc., are, however, all distinct from those of the other departments of the University. The classification of accounts is that prescribed by the auditors on the part of the Federal Government, and approved by the State Auditor. All of the accounts are audited by the State Auditor, and the Hatch Fund and Adams Fund accounts are also audited by the Office of Experiment Stations acting for the United States Secretary of Agriculture in accordance with Federal Law.

The income of the Station from public sources for the year that ended June 30, 1919, was:

U. S. Government, Hatch Fund appropriation	$15,000 00
U. S. Government, Adams Fund appropriation	15,000 00
State of Maine, Animal Husbandry investigation appropriation	5,000 00
State of Maine, Aroostook Farm investigation	5,000 00
State of Maine, Highmoor Farm investigations*	2,500 00

The cost of maintaining the laboratories for the inspection analyses is borne by analysis fees and by the State Department of Agriculture. The income from sales at the experiment farms is used for the expense of investigations. The printing is paid for by an appropriation to the University.

At Aroostook Farm there are in connection with the cooperative work with the Federal Department of Agriculture expenditures mostly under "labor" for the Department and for which the Station is reimbursed. There are also certain expenditures for the Department made from sales of crops from Department investigations that do not appear in the tabular statements. They are carried as distinct and separate accounts, always with credit balances, on the Station ledger.

*From January 1, to June 30, 1919.

REPORT OF THE TREASURER FOR YEAR ENDING JUNE 30, 1919.

DISBURSEMENTS.

	Hatch fund	Adams fund	Animal husbandry investigations
Salaries	$6851.45	$9726.27	$3920.25
Labor	2168.67	1973.28	56.00
Publications	125.38	--------	--------
Postage and Stationery	683.31	126.52	99.51
Freight and Express	149.22	82.31	6.77
Heat, light and power	566.83	299.35	16.88
Chemical and laboratory supplies		10.50	31.82
Seeds, plants and sundry supplies	475.52	287.06	29.25
Fertilizers	924.20	--------	--------
Feeding stuffs	1155.01	1810.54	196.80
Library	249.53	110.30	16.25
Tools, machinery and appliances	384.56	107.74	--------
Furniture and fixtures	45.28	--------	24.75
Scientific apparatus and specimens		10.03	31.68
Live stock	235.00	--------	--------
Traveling expenses	409.50	352.13	34.79
Contingent expenses	20.00	60.00	180.00
Buildings	556.54	43.97	355.25
Total	15000.00	15000.00	5000.00

REPORT OF THE TREASURER FOR YEAR ENDING JUNE 30, 1920

DISBURSEMENTS.

	Aroostook Farm	Highmoor Farm*	General account	Inspection analysis
Salaries	$1670.64	$400.00	$1698.62	$9610.89
Labor	5151.23	819.69	--------	--------
Publications	--------	--------	--------	--------
Postage and Stationery	41.89	11.55	25.22	640.02
Freight and Express	181.92	21.94	76.57	136.27
Heat, light and power	93.50	51.00	55.00	536.33
Chemical and laboratory supplies	--------	--------	--------	398.86
Seeds, plants and sundry supplies	1345.80	361.45	307.41	111.99
Fertilizers	3098.84	872.72	17.15	--------
Feeding stuffs	778.48	970.84	--------	--------
Library	--------	--------	28.30	.50
Tools, machinery and appliances	234.15	55.45	186.58	--------
Furniture and fixtures	138.57	25.25	--------	58.68
Scientific apparatus and specimens	--------	--------	--------	167.75
Live stock	310.00	560.00	48.50	--------
Traveling expenses	83.25	6.26	198.77	124.47
Contingent expenses	52.50	--------	33.57	43.88
Buildings	1916.95	--------	215.72	9.61
Total	15097.72	4156.15	2891.41	11839.25

*Six months, January 1 to June 30, 1919 over expenditure of $1656.15 paid from General Account receipts.

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